Effect of Inhaled Corticosteroid Therapy on CT Scan-Estimated Airway Dimensions in a Patient With Chronic Bronchitis Related to Ulcerative Colitis

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CT scanning allows assessment of airway-wall thickness and is useful for diagnosing and assessing various lung diseases, including asthma and COPD. Several studies have reported that CT scan-estimated dimensions are positively correlated with pulmonary function test results and a positive response to treatment. However, to our knowledge, airway disease complicated by inflammatory bowel disease has not yet been assessed using CT scan-estimated dimensions. A 61-year-old woman with ulcerative colitis (UC) complained of cough, sputum, and fever 4 months after undergoing a total colectomy and rectal mucosectomy. Examination of bronchial biopsy samples demonstrated lymphocytic and plasma cell infiltration of the epithelium and submucosa. CT scan-estimated dimensions indicated thickening of the airways. Chronic bronchitis complicated with UC was diagnosed, and high-dose inhaled corticosteroid therapy was prescribed. Three months later, the CT scan-estimated dimensions of the patient's airways, her symptoms, and pulmonary function test results were dramatically improved.

Abbreviations

Ai
lumen area
ALD
airway lumen diameter

Ao
outer airway area

AoD
airway outer diameter

Awt
airway wall thickness

IBD
inflammatory bowel disease

ICS
inhaled corticosteroid

UC
ulcerative colitis

WA
airway wall area

Case Report

A 61-year-old woman, diagnosed with ulcerative colitis (UC) at the age of 32 years, was treated with salazosulfapyridine. Despite administration of granulocyte apheresis, tacrolimus, and infliximab, the patient continuously experienced bloody diarrhea. The patient underwent a total colectomy and a rectal mucosectomy, at which time immunosuppressive treatment was discontinued. Four months later the patient complained of cough, purulent sputum, and fever without nocturnal exacerbation. Sputum examination revealed methicillin-resistant *Staphylococcus aureus*, and teicoplanin was administered for 14 days. Chest CT scans showed bronchial wall thickening and multifocal consolidations (Figs 1A, 1B). The patient had no history of respiratory symptoms, asthma, or cigarette smoking. She did have hypergammaglobulinemia, with an IgG level of 3,043 mg/dL (normal range, 826-1,840 mg/dL) and an IgA level of 514.1 mg/dL (normal range, 93-426 mg/dL). However, neither IgG4 nor IgE levels were significantly elevated. Bronchoscopic examination demonstrated severe, generalized mucosal inflammation and purulent secretions. Bronchial lavage yielded no evidence of respiratory pathogens. Examination of bronchial and transbronchial lung biopsy samples demonstrated lymphocytic infiltration in the epithelium and granulation tissue with lymphocyte and plasma cell infiltration in the submucosa and lymphocytic bronchiolitis. Eosinophilic infiltration was not observed (Fig 2). Lung function tests showed 92.4% of predicted FVC, 82.6% of predicted FEV₁, 76.2% of predicted FEV₁/FVC, and 53.8% of predicted diffuse capacity for carbon monoxide. Administration of inhaled β₂-agonist did not improve the FEV₁ percentage. We diagnosed chronic bronchitis complicated by UC in the patient. We prescribed high-dose inhaled corticosteroid (ICS) therapy with fluticasone propionate (400 µg bid), following which her respiratory symptoms rapidly improved.
Figure 1  A and C, Right lower lobes of the lungs from a high-resolution CT scan. After treatment, the lumen area increased and the airway wall thickness decreased. B and D, Left lower lobes of the lungs from a high-resolution CT scan. Multifocal consolidations were absent following treatment. A and B, Before 3 months of inhaled corticosteroid therapy. C and D, After 3 months of inhaled corticosteroid therapy. Arrows indicate the right B10.

Figure 2  Bronchial biopsy samples were taken via bronchoscopy. Histopathologic examination demonstrated lymphocytic infiltration in the epithelium and granulation tissue with lymphocyte and plasma cell infiltration in the submucosa. Eosinophilic infiltration was not observed (hematoxylin and eosin, original magnification × 200).

Three months later, following induction of ICS treatment, the patient’s lung function test results were improved: 109.6% of FVC, 116.3% of FEV1, 88.7% of FEV1/FVC, and 60.7% of the predicted diffuse capacity for carbon monoxide. The repeated CT scan showed improvement of airway thickening, and the previously seen multifocal consolidation was absent (Figs 1C, 1D). Airway lumen diameter (ALD), airway outer diameter (AoD), lumen area (Ai), and outer airway area (Ao) were measured using custom software. As indexes of airway wall dimensions, Ai was used for assessing luminal narrowing, and airway wall thickness (Awt) (Awt = (AoD - ALD)/2), Awt/ALD, airway wall area (WA) (WA = Ao - Ai), and percentage of WA (WA% = WA/Ao × 100) were used to assess airway remodeling. At the right B1, Ai increased from 15.41 mm².
to 20.44 mm^2, Awt decreased from 1.57 mm to 1.53 mm, and Awt/ALD decreased from 0.21 to 0.19. WA increased from 29.57 to 31.97 mm^2, and WA% decreased from 65.74% to 61.00%. At the right B10, Ai increased from 22.79 to 30.36 mm^2, Awt decreased from 1.72 to 1.34 mm, and Awt/ALD decreased from 0.19 to 0.15. WA decreased from 38.05 to 28.20 mm^2, and WA% decreased from 62.73% to 51.19%. There was no difference in lung volumes before (4.519 L) or after (4.517 L) treatment according to three-dimensional CT scan volumetric analysis. Therefore, with the exception of WA in B1, the CT scan-estimated airway wall dimensions were improved.

Discussion

Among the various pulmonary complications of inflammatory bowel disease (IBD), large airway diseases, including chronic bronchitis and bronchiectasis, are the most common manifestations. Occasionally, pulmonary complications develop after colectomy, as with this patient. The shifting of the inflammatory process from the bowel to the lung is likely related to the common ancestry of the bowel and the bronchial tree. In these cases, high-dose ICSs are considered the first-line treatment of large airway disease. ICS treatment improved the Awt and luminal narrowing, as evaluated by CT scanning in this patient, as well as respiratory symptoms and lung function.

Although IBD has been associated with asthma, this patient did not have nocturnal exacerbation, nor was she responsive to an inhaled β2-agonist. Histopathologic findings from the bronchial biopsy samples were consistent with previous reports of IBD, but not with reports of asthma. In patients with asthma, Awt estimated from CT scans was directly related to structural changes as assessed by examination of bronchial biopsy samples and response to ICS treatment. Consistent with previous studies of asthma, the airway wall thickening indicated from CT scans in this case was reflected in the histopathologic changes (Fig 2), and the reduction of Awt indicated improvement of the inflammatory and structural changes in the airway walls. In patients with asthma, FEV1 and WA% were significantly associated, and the posttreatment WA/body surface area was related to disease duration. This patient had low pretreatment FEV1 and FVC levels, consistent with chronic bronchitis suppuration associated with IBD. ICS treatment improved FEV1 and FVC levels, as well as the dimensions seen on CT scans, including WA% and Ai.

Other studies have shown that despite the use of high-dose ICS treatment of IBD, airway thickening remained in patients with treatment failure, and bronchiectasis sometimes rapidly progressed after colectomy. Camus et al recommended that ICS treatment should be administered relatively early in the course of IBD. We show that the changes seen on CT scans were indeed concordant with clinical findings in this patient with UC and that the CT scan-estimated thickening of airway walls thinned in response to ICS treatment. We feel that CT scanning offers insight into the mechanism of therapeutic response.

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REFERENCES: